REDDING GENERAL PLAN

SEISMIC SAFETY ELEMENT

Adopted by Redding Planning Commission, November 12, 1974

Adopted by Redding City Council, January 6, 1975

Prepared by the

Redding Department of Planning and

Community Development

94 00124

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I. INTRODUCTION

Following the disastrous effects of the San Fernando earthquake in 1971, the California State Legislature mandated that all General Plans shall include a Seismic Safety Element:

> "consisting of an identification and a appraisel of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis and seiches".*

The effect of this element is to require cities and counties to make seismic and geologic hazards a consideration of their local planning programs. The basic objective is to reduce loss of life, injuries, damage to property, and the economic and social dislocations resulting from future earthquakes. Essentially, it is the goal of the element to advocate the adoption of preventive measures before an earthquake occurs.

Prior to this requirement, many of the states local jurisdictions paid little attention to seismic activity in evaluating existing and proposed development. Concern was generally limited to the requirements of the building code or to the obvious seismic hazards of the area. Unfortunately, many jurisdictions still do not have the resources or the expertise available to administer an on-going seismic evaluation program.

It should be emphasized, that seismic activity is

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* California Government Code, Section 65302(f).

regional in nature, in that what happens in one place may also affect an area several hundred miles away. Proper planning should incorporate seismic performance standards on a regional basis with special emphasis given to local issues by the local agancy.

Current seismic information is based on what is observed of the present lay of the land, what man knows about geologic processes and from what has been encountered since the recorded occupation of the area. Existing information, for instance, does not tell us what lies under the alluvium of the Great Valley nor does it tell us when and where the next earthquake will occur. What we do know, is that California has had a historical and active pattern of earthquake activity up to the present time.

Through the adoption of a Seismic Safety Element, the City of Redding will incorporate the potential seismic hazard as is known at this time into its planning program in an effort to minimize to an acceptable level the possible harmful effects of earthquakes and other geologic hazards upon the community. The element will also aid in identifying those areas which require further study and evaluation. Continual review of the element will be necessary as new information becomes available or new techniques are developed.

II. TYPES OF SEISMIC HAZARD

Primary attention of this element is directed towards those geological hazards which occur or can occur as the result of earthquake activity. Most of them are directly related to earthquake activity in that the earthquake is the precipitating agent, whereas others may occur independently of an earthquake for other reasons. The State of California has delineated five major areas of critical seismic concern which shall be considered by the element. These include:

1. Surface ruptures
2. Ground shaking
3. Ground failure
4. Tsunamis
5. Seiches

All of these seismic hazards have a common denominator in that they have the potential to cause loss of life or damage to property.

The essential ingredient of seismic activity is the earthquake. Earthquakes occur on fault lines in the earth's crust. They are the primary agent for seismic activity and vary in intensity, location magnitude, and duration. Their effects may be felt either locally or regionally.

An earthquake occurs when there is a rupture of rock or breakage of earth material on opposite sides of a fault as a result of accumulation of stress in the material. This movement or breakage releases energy which moves outward from the epicenter in the form of seismic waves.

These seismic waves do not disperse in a uniform pattern. They travel at different rates of speed depending upon the type of material they are passing through. Generally, the more solid or dense the material, the less susceptible it is to seismic waves. Conversely, the alluvium of the Great

Valley would be highly conductive to seismic wave passage due to its loose unconsolidated nature.

Within the State of California, there are many faults that have been identified which have the potential for earthquake activity. Identification has been mainly by two methods: Observing the resultant land forms or from historical records. Most of the faults within the state are considered to have had no recent activity.

For the purposes of the Seismic Element, the State suggests that faults be classified into two classes, active or inactive. Broader classifications should be based on the type of land use contemplated or on the criticality of the structures at issue. For example, a dam would be a more critical structure than the conventional single family home.

An active fault is one that has moved in recent geologic time and which is likely to move again in the relatively near future. An inactive fault is one which shows no evidence of movement in the relatively near future and shows no evidence of movement in recent geologic time .

Fault displacement occurs when the earth on one side of a fault line moves in relation to the earth on the other side of the fault line. Displacement may be as little as several inches to many feet. Movement may occur in several directions which have been classified as: right-lateral, left-lateral, reverse, normal or oblique slope. If movement is some distance below the earth's surface, displacement may not be evident at the surface.

<u>Surface Rupture</u>

Surface rupture is fault displacement which is manifested on the surface of the earth. Its effects may also be felt below the surface with changes in water table or strata. Most,

if not all, major California earthquakes have been accompanied by some degree of surface rupture. Surface rupture can result in scraps, grabens, fractures, and pressures ridges. Surface rupture is important to planning in that structures built across fault lines may be torn apart or otherwise destroyed when a surface rupture occurs underneath or immediately adjacent to the structure.

Ground Shaking

Ground shaking is the oscillation or vibration of earth materials resulting from an earthquake. It is the most commonly experienced earthquake phenomenon because it may be felt at some distance from the epicenter. Ground shaking has the greatest impact on areas underlain by loose, water saturated, thick sediments such as those located within the planning area during the wet season.

Damage from ground shaking is caused by the transmission of earthquake vibrations from the ground into building structures. The resultant damage is related to structural design, type of construction, intensity, period, and duration of the ground motion.

Ground shaking has been the dominate form of seismic activity affecting the planning area. The effects of ground motion are measured by the intensity of the motion felt (Modified Mercalli Scale, Appendix A), whereas magnitude measures the amount of energy released when an earthquake occurs.

Ground Failure

Ground failure occurs when the stresses in the ground exceed the resistence of earth materials to deformation or rupture. Instability comes about when stresses are increased by natural or man-made causes, such as: earthquakes, fills, and ground water withdrawal.

1. Liquefaction - is the process, whereby water in unconsolidated sand and other granular materials is subjected to pressure usually caused by ground motion. The earthquake induced deformation transforms a stable granular material into a fluid in which the solid particles are in a virtual state of suspension, similar to quicksand. The effect is that ground literally flows out from under buildings.
2. Lateral spreading - is the squeezing of soft, saturated clays, which results in a rapid or gradual loss of strength in foundation materials, so that structures built upon them gradually settle or breakup as the soil flows out laterally.
3. Earth lurching - is the movement of the land at right angles to a vertical surface. This can result in the formation of cracks in the ground caused by the ground being thrown into undulating waves.
4. Landslides - do not necessarily require a steep slope on which to occur, particulary during earthquakes. Landslides can occur on slopes that are virtually flat and on subsurface inclines in soil depths ranging from a few feet to several hundred feet.
5. Differential settlement - is the non-uniform compaction of loose granular soils which has the water in it freed by liquefaction and forced to the surface. As the water is re-

moved from the subsurface, the ground settles. Differential settlement may also occur through simple compaction of areas underlain by sand or in fill areas of former sloughs and streams.

6. Subsidence - occurs usually in areas where there has been withdrawal of subsurface fluids over a long period of time. Subsidence can cover extensive areas as a result of activity by man.
7. Expansive soils - are earth materials which greatly increase in volume when they absorb water and shrink when they dry out. When buildings are placed on expansive soils, foundations may rise each wet season and fall each dry season. Movements may vary under different parts of a building leading to foundation crack, structural distortion, and door and window warping.
8. Erosion - is the wear and removal of material from one site and its deposition in another.

Tsunamis

Tsunamis are commonly called "tidel waves". Tsunamis are long period waterwaves that are seismically or tectonically induced in the oceans. Their principal impact is felt by coastal areas.

Seiches

Seiches are periodic oscillations of water levels in basins that occur as the result of wind and weather changes, earthquakes, landslides, and tectonic activity. Seiches may occur in harbors, bays, rivers, or other bodies of water.

III. EVALUATION OF LOCAL SEISMIC HAZARDS

Historically, very little seismic activity has occured in the Redding area as compared to other parts of California. The prevalent geologic process within the area has been the removal and deposition of sediments from the surronding highlands into the valley and the development of residual soils.

In a study prepared by Guyton and Scheel in 1974, Earthquake Hazard of Northeastern California, it was determined that for the last 120 years there has been only 291 $\pm$ 4 earthquakes recorded within the thirteen counties of northeastern California covered by the report. The four dubious earthquakes were reported during the 1800's and are of uncertain location or reality (See Figure 1).

Of the earthquake intensities reached within their study area, Guyton and Scheel found that 20 $\pm$ 2 reached an intensity of VI or greater, 9 $\pm$ 1 reached intensity VII or higher, and one may have reached a maximum intensity of VIII. Ninty percent (90%) of the earthquakes recorded in the region were of intensity V or less.

Within Shasta County, activity has been located generally in the mountainous section of the county with a concentration in the Lassen Park area. Only four of the earthquakes recorded in Shasta County have reached intensities of VI or greater.

Earthquakes originating outside of the thirteen county regional area have not had an effect greater than those earthquakes produced within the region. Redding has felt earthquakes originating in both Del Norte and Humboldt counties (See Figure 2).

It has been estimated from the scant data available, that none of the earthquakes originating within the thirteen counties has produced a magnitude greater than 6.5 on the Richter Scale.

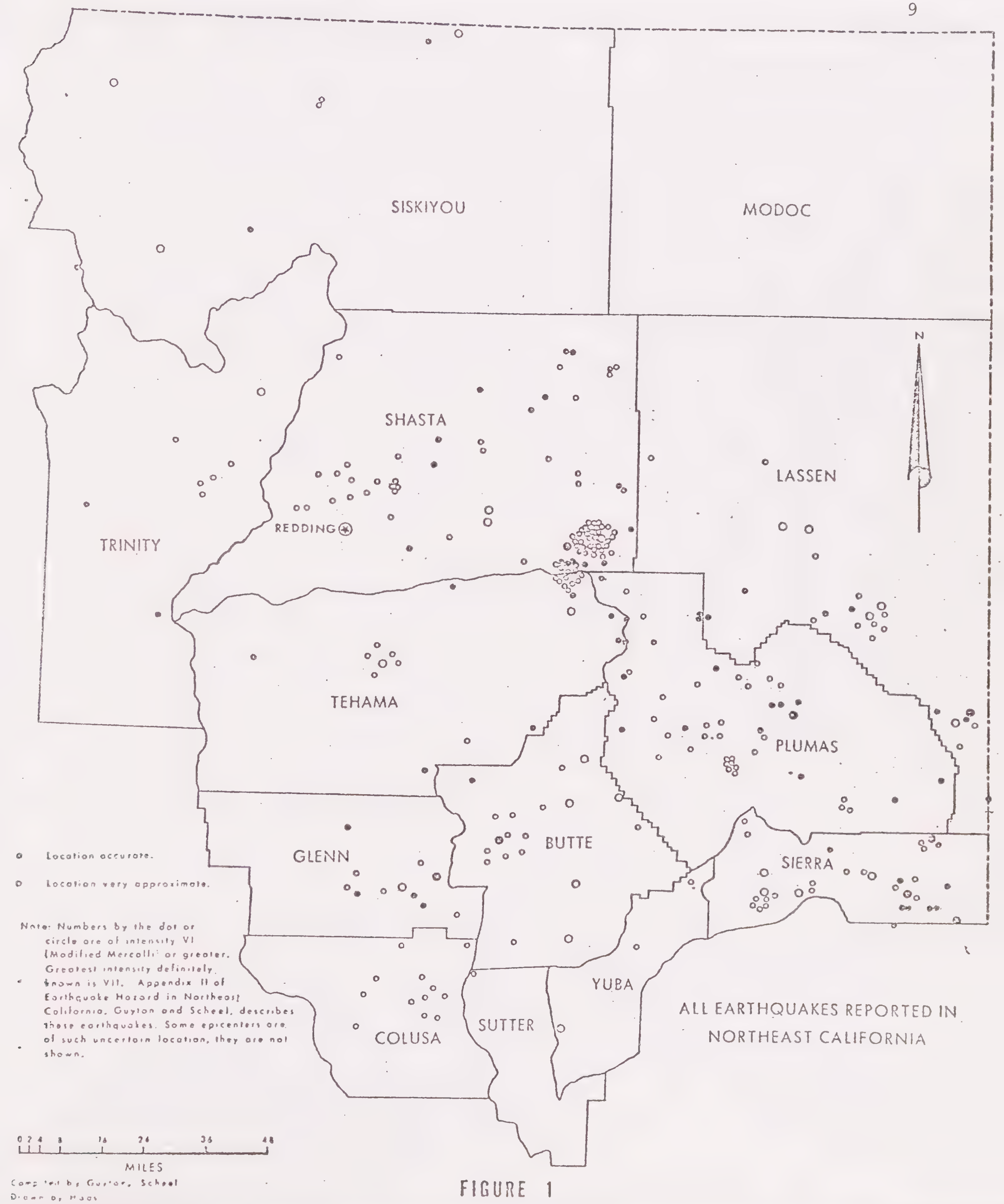

SISKIYOU
MODOC
SHASTA
LASSEN
TRINITY
REDDING
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
COLUSA
SUTTER
YUBA
N
Location accurate.
Location very approximate.
Note: Numbers by the dot or circle are of intensity VI (Modified Mercalli) or greater. Greatest intensity definitely known is VII. Appendix II of Earthquake Hazard in Northeast California, Guyton and Scheel, describes these earthquakes. Some epicenters are of such uncertain location, they are not shown.
0 2 4 8 16 24 36 48
MILES
Compiled by Guyton, Scheel
ALL EARTHQUAKES REPORTED IN NORTHEAST CALIFORNIA

FIGURE 1

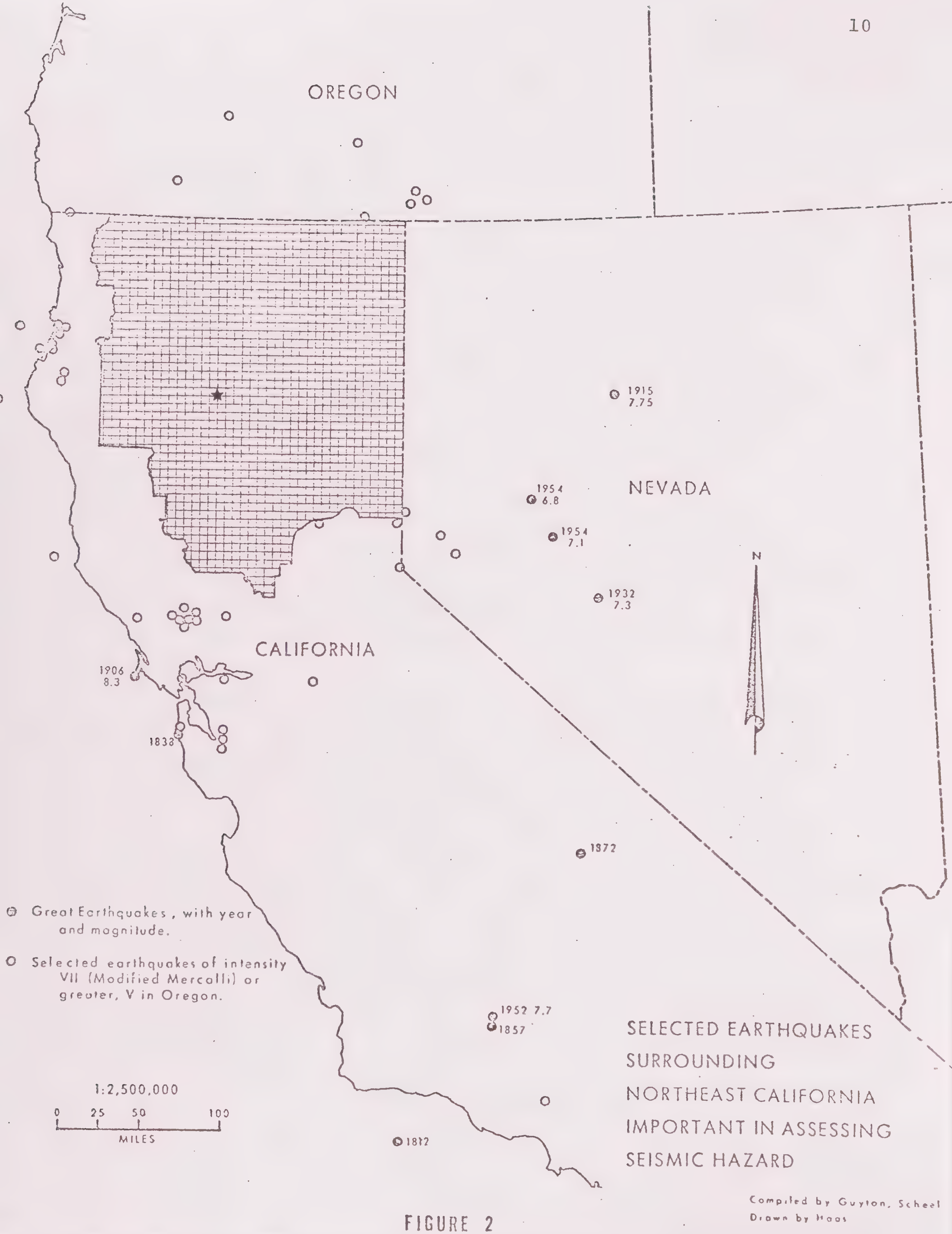

OREGON
NEVADA
CALIFORNIA
1915
7.75
1954
6.8
1954
7.1
1932
7.3
1906
8.3
1838
1872
1952 7.7
1857
1812
N
Great Earthquakes, with year and magnitude.
Selected earthquakes of intensity VII (Modified Mercalli) or greater, V in Oregon.
1:2,500,000
0 25 50 100
MILES
SELECTED EARTHQUAKES SURROUNDING NORTHEAST CALIFORNIA IMPORTANT IN ASSESSING SEISMIC HAZARD
Compiled by Guyton, Scheel
Drawn by Haas

FIGURE 2

T A B L E I

EARTHQUAKES OF NORTHEAST CALIFORNIA, 1851-1971
(All reports prior to 1931 have been converted from Rossi-Forel to Modified Merchalli)

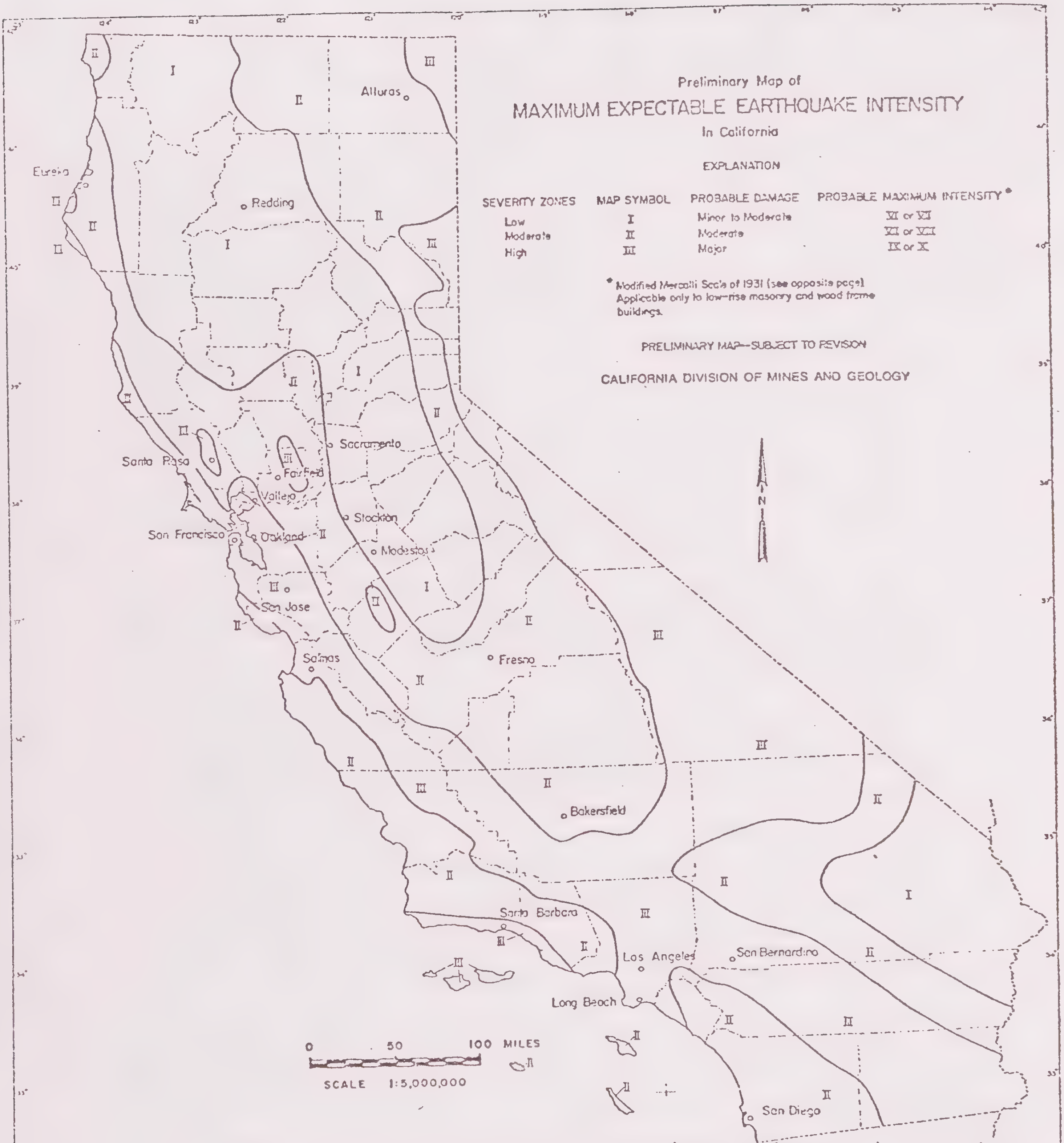
Intensity (Modified Marchalli)	Number of earthquakes	Percent of Total earthquakes
I to III	153	52
IV	68	24
V	41	14
VI	20 plus 2?	7
VII	9 plus 1?	3
VIII	0 plus 1?	less than 1
TOTAL	291 plus 4?	

Source: Guyton & Scheel, Earthquake Hazard in Northeast California, July 1974.

The California Division of Mines and Geology in their Bulletin No. 198, Urban Geology Master Plan For California, place the Redding area in a zone of low earthquake severity expectancy (See Figure 3).

The maximum earthquake intensity expected to occur in this zone is VI or VII. The 1973 edition of the Uniform Building Code classifies all of California in Seismic Risk zone 3, which corresponds to intensity VIII or higher on the Modified Mercalli Scale of 1931.

Guyton and Scheel concluded from their study of recorded earthquake activity in northeastern California, that "planning within the region should be based on a maximum intensity of VIII". Their recommendation falls between that of the generalized earthquake risk map of the Division of Mines and Geology that of the Uniform Building Code.



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973.

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FIGURE 3

The measure of earthquake intensity is of more practical use to the planner in that it is a measure of the strength of an earthquake and its effects upon people, buildings; and objects; whereas, earthquake magnitude is the measure of the amount of energy released by an earthquake, but not its impact.

One other consideration that can be included here is the maximum probable ground acceleration that an earthquake can produce. In a study prepared for the State Department of Water Resources by Bay-Valley Consultants in 1974, Recommended Water Quality Management Plan, the maximum probable bedrock acceleration for the Redding area is estimated to be 0.1 g or less.

The evaluation of the hazards of seismic activity in the planning area and for Shasta County as a whole requires the development of substantial amount of geologic and seismic data and its interpretation. Some of this data has already been developed, but it is of anoy general and limited scope. For Example, area soil surveys are addressed to the suitability of the soil for agriculture and not for Urban Development. It is imperative that basic seismic data be acquired on a regional basis with specific studies being made on the local level.

Fault Displacement

Within the planning area there are no active faults known to exist at this time, although, subsurface-concealed faults may exist. There are several small inactive faults on the westside of the planning area which are delineated on a map prepared for the Division of Mines and Geology by Charles W. Jenning in 1973. State of California, Preliminary Fault and Geologic Map. These faults are considered to be Pre-Quaternary (older than 2 million years) and for purposes of this element were not taken into consideration. Throughout Shasta County, as a whole, there are many of these Pre-Quaternary faults.

The nearest active faults to the planning area shown by Jennings are in Lassen, Plumas, Sierra and Humboldt counties. Figure 4 shows a more generalized map than that compiled by the Division of Mines and Geology.

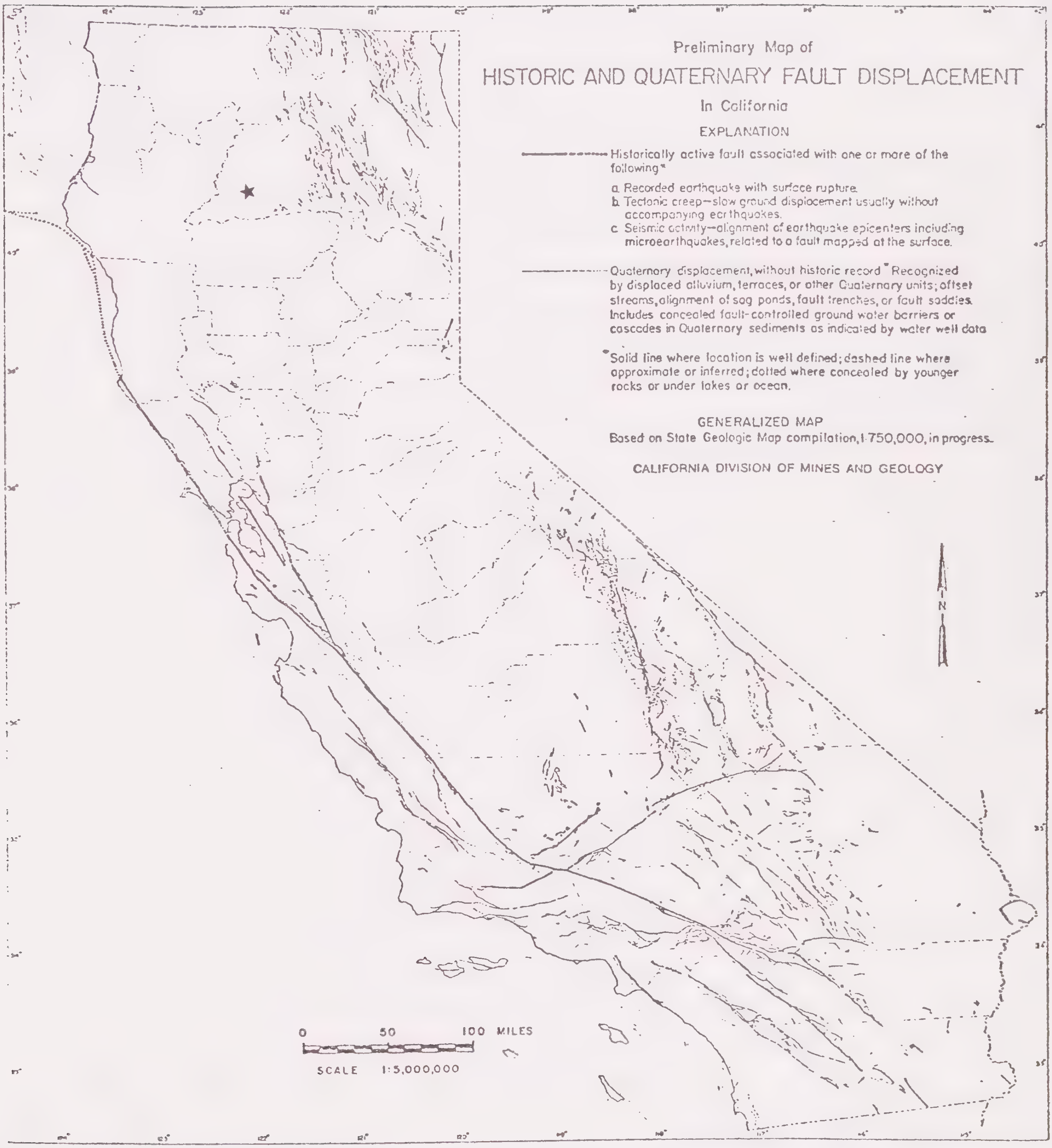
It is not expected that the effects of fault displacement will be manifested in the planning area, although associated secondary effects such as ground shaking will be a factor. Based on the present level of information, surface ruptures associated with fault displacement are not expected to occur within the planning area.

Ground Shaking

Most of the seismic damage expected to occur within the planning area will be as a result of ground shaking. Maximum probable intensities that are expected to develop may reach as high as VIII; therefore, it is recommended that intensity VIII be the design level for critical structures or uses. Guyton and Scheel in analyzing their information report that historical earthquake damage that has occured within the thirteen north-eastern California counties has been minor in nature, consisting of damage to chimmeys, windows and minor wall movements.

Ground Failure

1. Liquefaction - there are no reported cases of liquefaction within the planning area, however, the potential does exist for occurance on the portions of the planning area which can become saturated during the wet season.
2. Lateral spreading - Again, there are no reported cases of this phenomenon within the area, however, development on clay soils should be watched for this hazard.
3. Earth lurching - It is expected that minor earth lurching has occurred in the past. A severe earthquake in the future could induce this hazard into the planning area.
4. Landslides - There are no reported major landslide events affecting the planning area, however, there have been cases where slippage has occured.



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973.

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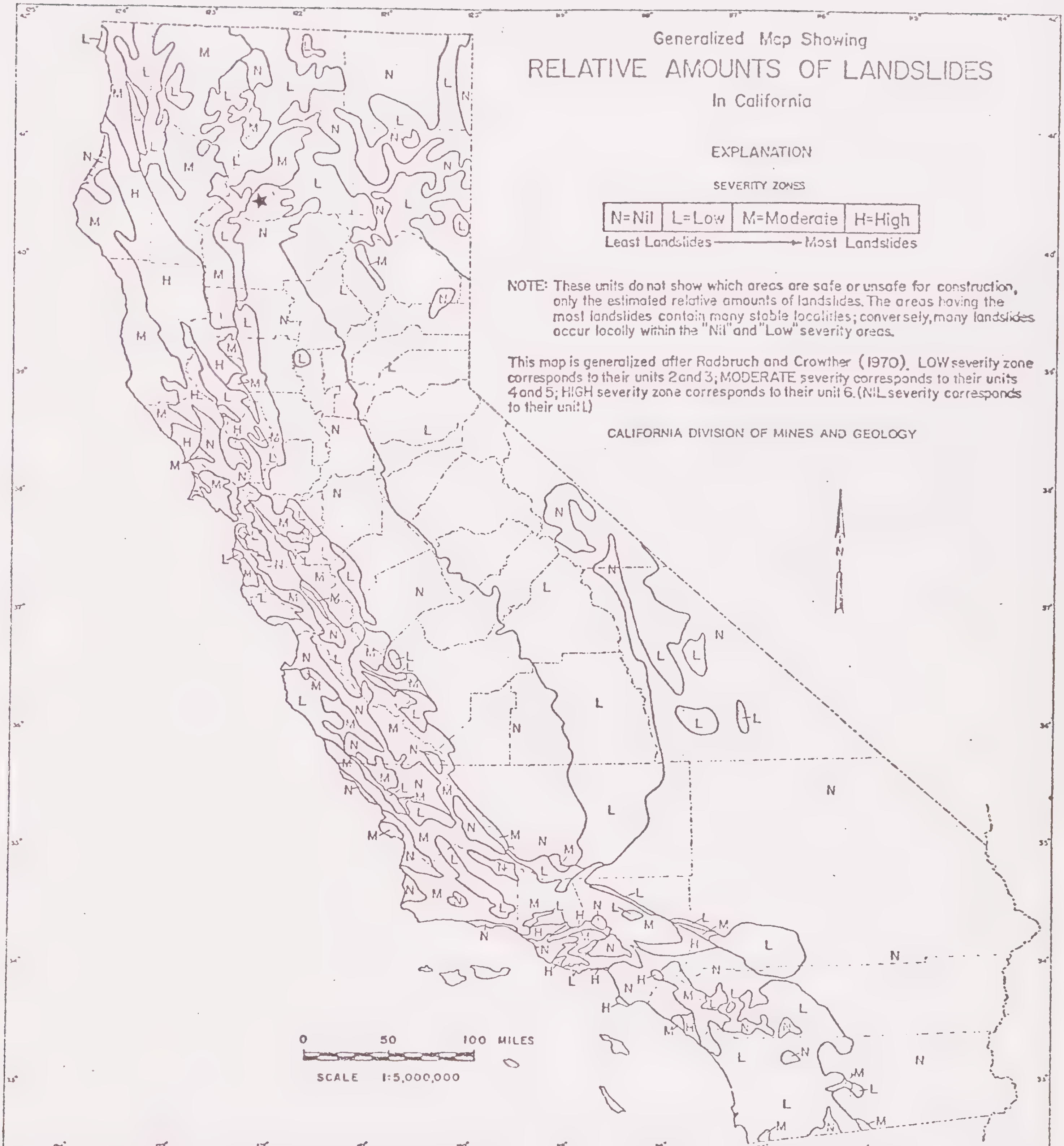
FIGURE 4

The possibility of slides or slippage does exist on steep slopes that can become water saturated or are subject to undercutting by the Sacramento River. The Division of Mines and Geology places Redding at a boundary zone intersection where landslide hazard ranges from nil to moderate. (See Figure 5)

5. Differential settlement - Again, there are no reported cases of this event, however, development over filled in sloughs, ditches, abandoned substructures, gullys or stream channels should be monitored to alleviate this problem.
6. Subsidence - There are no reports of areal subsidence in the planning area. To occur, significant amounts of fluids would have to be removed from the areas alluvial soils which are most susceptible to this hazard. Generally, the Division of Mines and Geology rates this hazard as non-existent in the planning area. (See Figure 6)
7. Expansive soils - Soil expansiveness is rated low to moderate throughout the planning area. Soil maps prepared by the Soil Conservation Service should be consulted or soil engineering test made to determine each sites specific characteristics. (See Figure 7)
8. Erosion - Erosion can be a problem in the planning area either through removal of material or by its deposition. In the "Open Space and Conservation Element" of the Redding General Plan, a map based on the area soil survey by the Soil Conservation Service delineates the areas erosion hazard.



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973.

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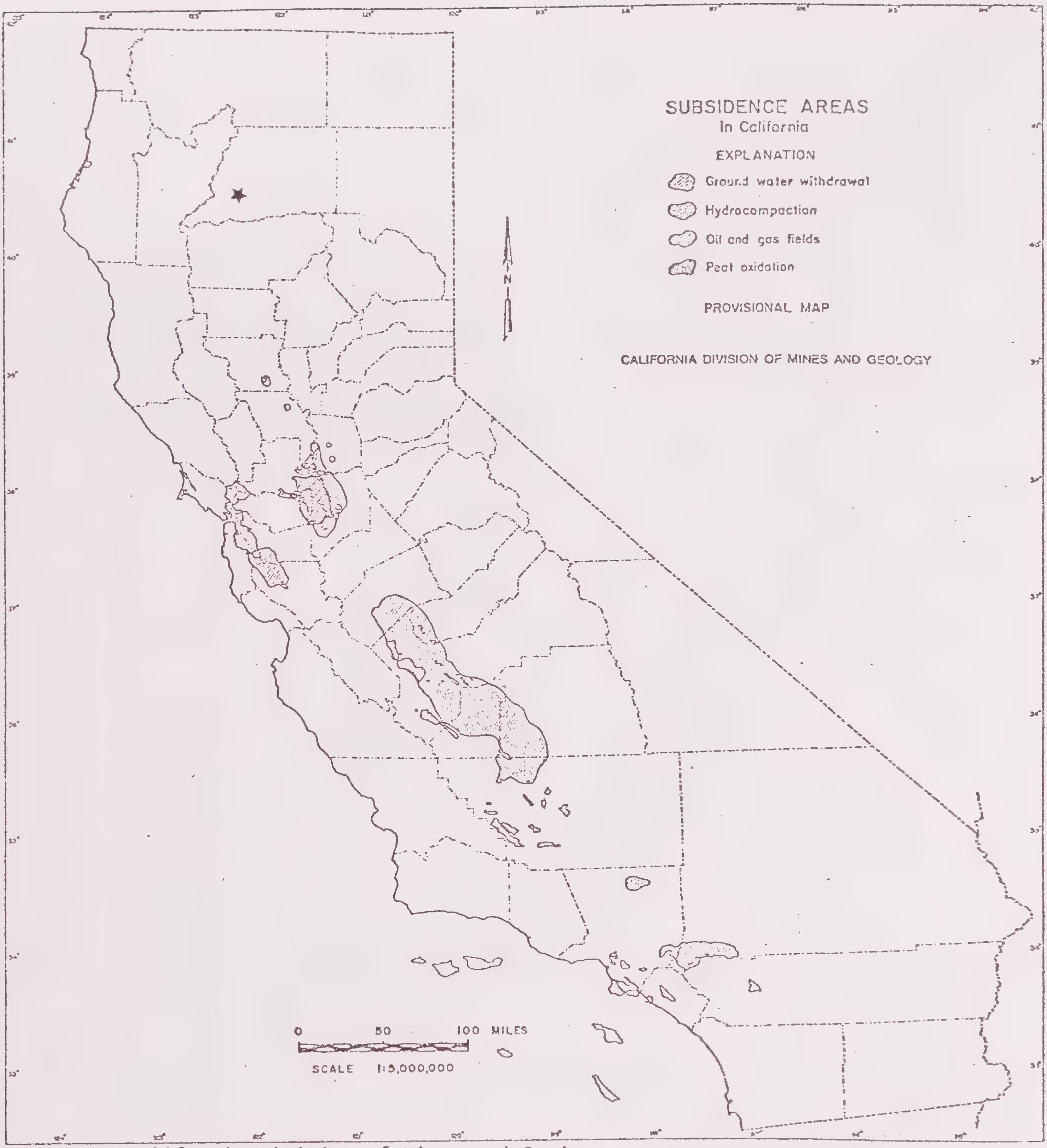
FIGURE 5



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973

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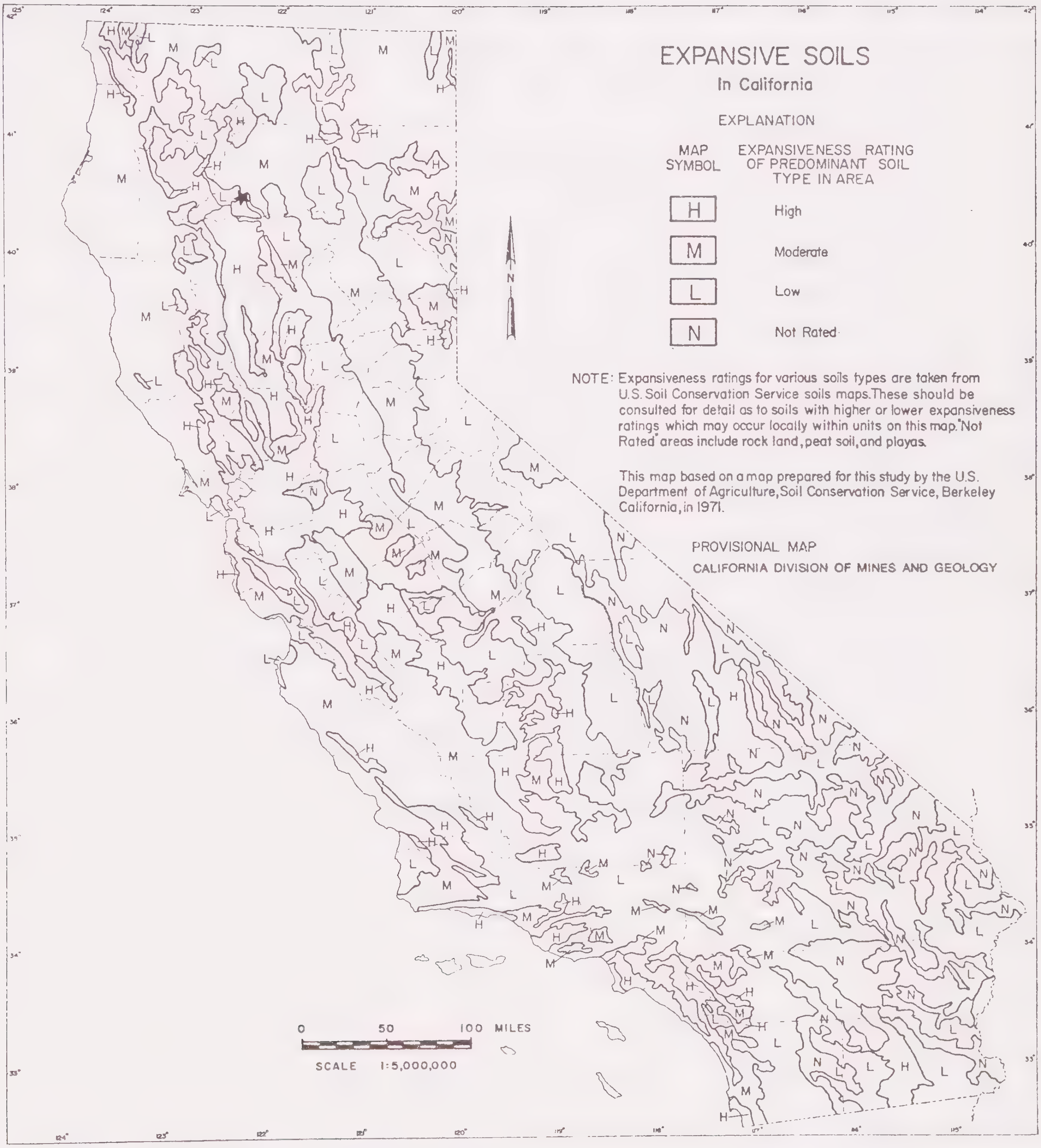
FIGURE 6



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973.

FIGURE 7

The general indication map put out by the California of Mines and Geology rates the erosion potential of the area from low to high depending upon soil type, slope and runoff. (See Figure 8)

Tsunamis

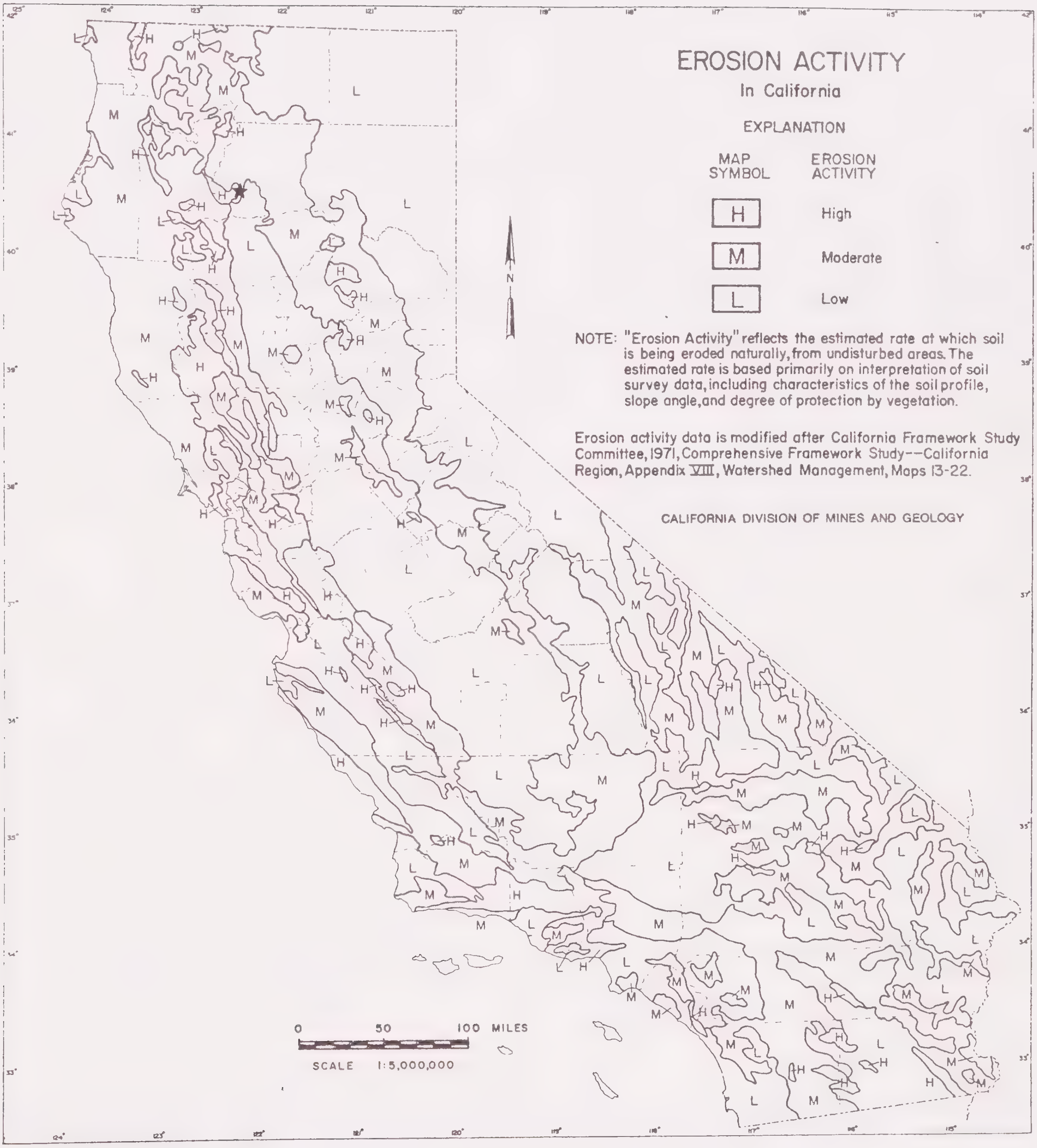
Due to the planning areas distance from the Pacific Ocean, there is not expected to be any hazard from Tsunamis.

Seiches

Seiches could be a severe problem depending upon various circumstances such as the time of year when the seiche occurs and the strength of the seiche inducing agent. Water could be spilled out of irrigation canals, reserviors, and the Sacramento River. Flood inumdation maps being prepared for Shasta, Keswick and Whiskeytown Dams showing areas of potential flooding in the event of total or partial failure should be analyzed when completed for impact upon the planning area.

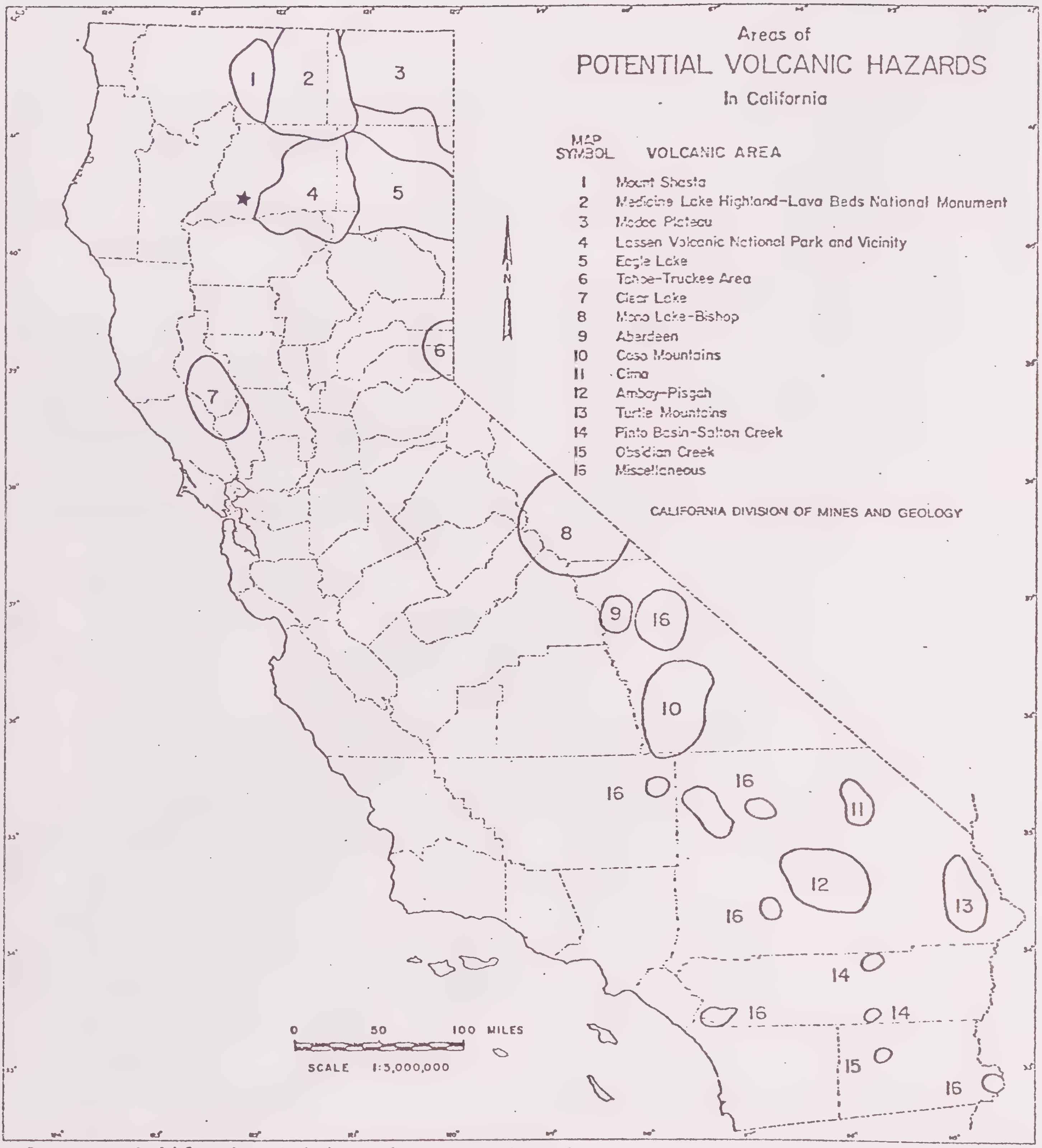
Volcanism

Volcanic activity has been an important factor in the formation of much of northeastern California. Based on past activity, the Division of Mines and Geology forsees the eastern half of Shasta County as a potential area of volcanic activity or volcanically induced hazards. Major eruptions of Mt. Shasta or Mt. Lassen could trigger earthquakes which may affect the planning area. Figure 9 depicts areas in California of potential volcanic activity.



Source: California Division of Mines and Geology, Urban Geology Master Plan, 1973.

FIGURE 8



Source: California Division of Mines and Geology, Urban Geology Master Plan 1973.

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FIGURE 9

VI. CONCLUSION

From reviewing the limited data available at the present time, it appears that an extreme seismic hazard does not exist in the Redding Area. Recent adoption by the City of the 1973 edition of the Uniform Building Code and the requirement for submission of soil reports prior to subdivision approval, should if strictly enforced, provide the community an adequate level of reasonable seismic safety. Structural design standards required by the Uniform Building Code will require new construction to be designed for an intensity level of IX.

V. APPENDICES

APPENDIX A

MODIFIED - MERCALLI INTENSITY SCALE

I. Not felt by people, except under especially favorable circumstances. However, dizziness or nausea may be experienced.

Sometimes birds and animals are uneasy or disturbed. Trees, structures, liquids, bodies of water may sway gently, and doors may swing very slowly.

II. Felt indoors by a few people, expecially on upper floors of multi-story buildings, and by sensitive or nervous persons.

As in Grade I, birds and animals are disturbed, and trees, structures, liquids and bodies of water may sway. Hanging objects swing, especially if they are delicately suspended.

III. Felt indoors by several people, usually as a rapid vibration that may not be recognized as an earthquake at first. Vibration is similar to that due to passing of a light, or lightly loaded trucks, or heavy trucks some distance away. Duration may be estimated in some cases.

Movements may be appreciable on upper levels of tall structures. Standing motor cars may rock slightly.

IV. Felt indoors by many, outdoors by few. Awakens a few individuals, particularly light sleepers, but frightens no one except those apprehensive from previous experience. Virbation like that due to passing of heavy or heavily loaded trucks. Sensation like a heavy body striking building, or the falling of heavy objects inside.

Dishes, windows and doors rattle; glassware and crockery clink and clash. Walls and house frames creak, especially if intensity is in the upper range of this grade. Hanging objects often swing. Liquids in open vessels are disturbed slightly. Stationary automobiles rock noticeable.

V. Felt indoors by practically everyone, outdoors by most people. Direction can often be estimated by those outdoors. Awakens many, or most sleepers. Frightens a few people, with slight excitement; some persons run outdoors.

Buildings tremble throughout. Dishes and glassware break to some extent. Windows crack in some cases, but not generally. Vases and small or unstable objects

APPENDIX A

MODIFIED - MERCALLI INTENSITY SCALE

(continued)

V. (continued)

overturn in many instances, and a few fall. Hanging objects and doors swing generally or considerably. Pictures knock against walls, or swing out of place. Doors and shutters open or close abruptly. Pendulum clocks stop, or run fast or slow. Small objects move, and furnishings may shift to a slight extent. Small amounts of liquids spill from well-filled open containers. Trees and bushes shake lightly.

VI. Felt by everyone, indoors and outdoors. Awakens all sleepers. Frightens many people; general excitement, and some persons run outdoors.

Persons move unsteadily. Trees and bushes shake slightly to moderately. Liquids are set in strong motion. Small bells in churches and schools ring. Poorly built buildings may be damaged. Plaster falls in small amounts. Other plaster cracks somewaht. Many dishes and glasses, and a few windows, break. Knickknacks, books and pictures fall. Furniture overturns in many instances. Heavy furnishings move.

VII. Frightens everyone. General alarm, and everyone runs outdoors.

People find it difficult to stand. Persons driving cars notice shaking. Trees and bushes shake moderately to strongly. Waves form on ponds, lakes and streams. Water is muddied. Gravel or sand stream banks cave in. Large church bells ring. Suspended objects quiver. Damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in poorly built or badly designed buildings, adobe houses, old walls (especially where laid up without mortar), spires, etc. Plaster and some stucco fall. Many windows and some furniture break. Loosened brickwork and tiles shake down. Weak chimneys break at the roofline. Cornices fall from towers and high buildings. Bricks and stones are dislodged. Heavy furniture overturns. Concrete irrigation ditches are considerably damaged.

APPENDIX A

MODIFIED - MERCALLI INTENSITY SCALE

(continued)

VIII. General fright, and alarm approaches panic.

Persons driving cars are disburbed. Trees shake strongly, and branches and trunks break off (especially palm trees). Sand and mud erupt in small amounts. Flow of springs and wells is temporarily and sometimes permanently changed. Dry wells renew flow. Temperature of spring and well waters varies. Damage slight in brick structures built especially to withstand earthquakes; considerable in ordinary substantial buildings, with some partial collapse; heavy in some wooden houses, with some tumbling down. Panel walls break away in frame structures. Decayed pilings break off. Walls fall. Solid stone walls crack and break seriously. Wet ground and steep slopes crack to some extent. Chimneys, columns, monuments and factory stacks and towers twist and fall. Very heavy furniture moves conspicuously or overturns.

IX. Panic is general.

Ground cracks conspicuously. Damage is considerable in masonry structures built especially to withstand earthquakes; great in other masonry buildings--some collapse in large part. Some wood frame houses built especially to withstand earthquakes are thrown out of plumb, others are shifted wholly off foundations. Reservoirs are seriously damaged and underground pipes sometimes break.

X. Panic is general.

Ground, especially when loose and wet, cracks up to widths of several inches; fissures up to a yard in width run parallel to canal and stream banks. Landsliding is considerable from river banks and steep coasts. Sand and mud shifts horizontally on beaches and flat land. Water level changes in wells. Water is thrown on banks of canals, lakes, rivers, etc. Dams, dikes, embankments are seriously damaged. Well-built wooden structures and bridges are severely damaged, and some collapse. Dangerous cracks develop in excellent brick walls. Most masonry and frame structures, and their foundations, are destroyed. Railroad rails bend slightly. Pipe lines buried in earth tear apart or are crushed endwise. Open cracks

APPENDIX A

MODIFIED - MERCALLI INTENSITY SCALE

(continued)

X. (continued)

and broad wavy folds open in cement pavements and asphalt road surfaces.

XI. Panic is general.

Disturbances in ground are many and widespread, varying with the ground material. Broad fissures, earth slumps, and land slips develop in soft, wet ground. Water charged with sand and mud is ejected in large amounts. Sea waves of significant magnitude may develop. Damage is severe to wood frame structures, especially near shock centers; great to dams, dikes and embankments, even at long distances. Few if any masonry structures remain standing. Supporting piers or pillars of large, well-built bridges are wrecked. Wooden bridges that "give" are less affected. Railroad rails bend greatly, and some thrust endwise. Pipe lines buried in earth are put completely out of service.

XII. Panic is general.

Damage is total, and practically all works of construction are damaged greatly or destroyed. Disturbances in the ground are great and varied, and numerous shearing cracks develop. Landslides, rock falls, and slumps in river banks are numerous and extensive. Large rock masses are wrenched loose and torn off. Fault slips develop in firm rock, and horizontal and vertical offset displacements are notable. Water channels, both surface and underground, are disturbed and modified greatly. Lakes are dammed, new waterfalls are produced, rivers are deflected, etc. Surface waves are seen on ground surfaces. Lines of sight and level are distorted. Objects are thrown upward into the air.

Source: Planning Commission Subcommittee on Land Use and Development Regulations, <u>Hayward Earthquake Study</u>, April, 1972

APPENDIX B

Some Northeast California Earthquakes

1855	Large pinnacle of rock on the Downieville Buttes thrown down.
1866	Siskiyou County. Klamath River changed course, accompanied by landslide (may not have been earthquake).
1869	Report of $5,000 damage to buildings in Oroville. (Whether local or from earthquake in Nevada is unknown. Report may be inaccurate).
1885	Glass broken and chimneys shaken down in Lassen County.
1888	Plaster cracked at Biggs.
1889	Lassen County, chimney thrown down at Willow Creek; Eagle Lake became muddy; crockery and glassware broken in Susanville.
1903	Willows, several brick walls cracked and plaster fell from many buildings.
1908	Chimneys thrown down in Lassen County.
1909	Chimneys damaged at Downieville. Minor damage to flumes, chimneys, plaster, and dishes in Sierra and Plumas Counties.
1915	Shasta County, Twin Valley; earth cracked, rocks thrown about, barn sagged, house tipped to one side. (Puzzling account; nothing recorded at Berkeley seismograph, nothing felt at Redding).
1919	Shasta County; chimneys damaged, ground fractured near Whitmore and Fern (puzzling account, similar to 1915 above).
1928	Chimneys thrown down at Weaverville.
1936	Rock slides reported on Lassen Peak and Chaos Crags.
1940	Chimneys cracked or twisted at several places in Butte County; plaster cracked at numerous places.
1945	Water pipes broken at Paradise, Butte County.
1948	Plaster cracked.

APPENDIX B

Some Northeast California Earthquakes

(continued)

1950	Herlong, Lassen County; building shifted on foundation, buildings cracked; some underground pipes damaged; many chimneys broken; trusses and rafters split. Lesser damage in Doyle.
1950	Doyle; earth fracture in Long Valley.
1956	Plaster cracked at home near Manzanita Lake.
1958	Chimneys cracked at Hallelujah Junction, Lassen County.
1959	Loyalton; several chimneys fell, walls cracked, considerable glassware and merchandise fell.
1966	Plaster cracked at Forest Ranch (Butte County), rocks heard rolling downhill east of Oroville. Some telephone service interrupted at Forest Ranch.
1966	Loyalton; lumber shed nearly collapsed, chimneys fell, walls cracked, fireplace collapsed, and hair-line cracks in cement block building.
1968	Chico; glass door broke in High School, several burglar alarms activated. Willows; plaster cracked.

Source: Guyton and Scheel, Earthquake Hazard in northeast California, July 1974.

APPENDIX C

Great Earthquakes of California, Nevada, and Oregon

Date, Location, Magnitude	Remarks
1812, Dec. 21 Southern California Mag. Unknown	Disastrous in southern California no mention of northeast California
1838, June San Francisco Mag. Unknown	"Very severe" in San Francisco region to Monterey. No mention of northeast California
1857, Jan. 9 Southern California Mag. about 8.3	Possibly the potentially most destructive earthquake in coastal California ever. No mention of northeast California.
1872, March 26 Owens Valley Mag. Possible 8.3+	Probably the greatest earthquate ever recorded in California and Nevada. Very destructive of property and lives. Int. VI in Chico, Marysville; IV-V Red Bluff; V in Downieville.
1906, April 18 San Francisco Mag. 8.3	<u>The</u> great California earthquake of popular knowledge. Great destruction in San Francisco bay area. Maximum intensity of V in southeast part of northeast California.
1915, Oct. 2 Nevada Mag. 7 3/4	Felt over 500,000 sq. miles from Oregon to southern California. Intensities from II to V reported throughout northeast California.
1934, Dec. 20 Western Nevada Mag. 7.3	Extensive faulting, some damage in epicentral area. Felt over 500,000 mi. square. Maximum intensity V from northeast California.
1952, July 21 Kern County Mag. 7.7	Felt over 160,000 mi. square, 12 killed, $50 million damage. Intensity I-IV as far north as Red Bluff, imperceptible north of there.

APPENDIX C

Great Earthquakes of California, Nevada, and Oregon

(continued)

Date, Location, Magnitude	Remarks
1954, August 23 Western Nevada Mag. 6.8	Extensive damage in Nevada. Maximum intensity of V in eastern part of northeast California.
1954, Dec. 16 Dixie Valley, Nevada	Faulting 55 miles long. Damage in Nevada. Intensity V in east from Modoc County to Sierra County, IV or less elsewhere.

Source: Guyton and Scheel, Earthquake Hazard in northeast California, July 1974.

APPENDIX D

Selected Moderate Earthquakes of
California, Nevada, and Oregon

Date, Location, Intensity	Damage - NE California
1836 San Francisco X	None
1860 Humboldt Bay VIII	None
1861 Contra Costa Co. VIII	None
1865 Sonoma Co. VII	None
1865 Eureka VIII-IX	None
1869 Virginia City, Nev. IX	Some damage in Downieville. Oroville suffered $5,000 damage (but may have been another event).
1871 Mendocino Co. VII	None
1873 Del Norte Co. VII	Strong in Trinity Co. Felt in Red Bluff and Redding.
1876 Sonoma Co. VII	None
1881 Stanislaus Co. VII	Felt in Greenville.
1887 Carson City, Nev. VII	None
1888 Sonoma Co. VII	None
1889 San Francisco	None
1891 Napa Co. VII-VIII	None
1892 Vacaville, Solano Co., IX	None
1892 Winters, Yolo Co. IX	Minor damage in Butte and Yuba Co. Felt in Red Bluff.
1893 Sonoma Co. VII	None
1898 Mendocino Co. VIII-IX	None
1908 Humboldt Co. VII	None
1909 Humboldt Co.	Severe throughout Shasta Co., but damage was trivial. Felt widely in other places.

APPENDIX D

Selected Moderate Earthquakes of California, Nevada, and Oregon

(continued)

Date, Location, Intensity	Damage - NE California
1914 Reno, Nev. VII	Intensity IV at Susanville, no damage
1920 Crater Lake, Oregon V	None
1923 Southern Oregon V	Plaster fell at Alturas; Intensity III at Susanville.
1927 Humboldt Bay VIII	Felt in Trinity County, no damage.
1931 Talent, Oregon V	None
1932 Humboldt Co. VIII	Felt in Bieber, Shasta and Shasta Springs; no damage. Intensity IV at Anderson, Chico, Paradise, McCloud; no damage.
1933 Wabuska, Nevada VII	IV at Chico, Williams, Willows; no damage.
1948 Verdi, Nevada VII	VI at Loyalton, Sierraville; very minor damage; V at Butte City, Colusa, Downieville, Gridely, Marysville, Quincy, Susanville, Willows; no damage.
1951 Cape Mendocino VII	V at Red Bluff and Willows; no damage.
1954 Eureka VII	VI broke 10" wooden water main in McCloud; VI Slight damage in Castella; chimney twisted in Red Bluff; two windows cracked in Redding; intensity I-III in Alturas and Chico; slight damage in Orland; two windows cracked at City Hall, Redding.
1962 Lake Co. VII	None
1968 Santa Rosa VII	None

APPENDIX D

Selected Moderate Earthquakes of
California, Nevada, and Oregon

(continued)

Date, Location, Intensity	Damage - NE California
1968 Adel, Oregon V	None
1968 Calif.-Oregon Border V	V at Modoc County
1968 Calif.-Oregon Border VI	VI at Fort Bidwell, Modoc County, house sustained cracking of foundation, some shifting of frames and walls.
1969 Santa Rosa, VII-VIII	III in Sutter County
1971 San Fernando, Calif. XI	Not felt.

Source: Guyton and Scheel, Earthquake Hazard in northeast California, July 1974.

RESOLUTION NO. 2552

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF REDDING AMENDING THE GENERAL PLAN OF THE CITY OF REDDING BY ADDING A SEISMIC SAFETY ELEMENT TO THE SAID GENERAL PLAN.

WHEREAS, Government Code Section 65302 requires the General Plan to include a Seismic Safety Element consisting of an identification and appraisal of seismic hazards and geologic hazards, and

WHEREAS, the Planning Department has prepared a Seismic Safety Element in order to comply with the above statutory requirements, and

WHEREAS, the Planning Commission met on Tuesday, November 12, 1974, in public hearing and noticed in accordance with law, and approved the attached Seismic Safety Element and recommended that Council adopt and incorporate this Seismic Safety Element within the General Plan of the City of Redding, and

WHEREAS, the City Council has received the said recommendation and considered the said Seismic Safety Element and considers the adoption of same to be in the best interests of the City of Redding,

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Redding does hereby adopt the attached Seismic Safety Element, marked "Exhibit A" and incorporated herein by reference, as the Seismic Element for the City of Redding.

BE IT FURTHER RESOLVED that the said Seismic Safety Element be incorporated within the General Plan of the City of Redding as an addition thereto and amendment thereof.

I HEREBY CERTIFY that the foregoing Resolution was introduced and read at a regular meeting of the City Council of the City of Redding on the 6th day of January, 1975, and was duly adopted at said meeting by the following vote:

AYES: COUNCILMEN: Anderson, Demsher, Fulton, Pugh, and Denny
NOES: COUNCILMEN: None
ABSENT: COUNCILMEN: None

Charles T. Denny
CHARLES T. DENNY
Mayor of the City of Redding

ATTEST:

MILDRED L. BRAYTON, City Clerk

FORM APPROVED:

Earl D. Murphy
EARL D. MURPHY, City Attorney

APPENDIX F

ENVIRONMENTAL IMPACT ASSESSMENT OF THE SEISMIC SAFETY ELEMENT

The guidelines adopted by the State Resources Agency require that an environmental impact report be prepared for the adoption or amendment of a general plan or element thereof, except where the general plan or element thereof addresses all the points required to be in an environmental impact report and the document contains a section or cover-sheet identifying where the general-plan document addresses each of the points required.

The guidelines for the preparation of an EIR list nine general areas to be reviewed. However, since the guidelines are designed for specific project proposals, it is not possible to address each of the areas with the same degree of specificity that would be covered for individual projects. With this perspective in mind, the following environmental assessment is attached to the Seismic Safety Element to illustrate the relationship between the element and the requirements of the California Environmental Quality Act.

SECTION I - DESCRIPTION OF THE PROJECT

A. Location.

Shown on maps supplied in the Element.

B. Purpose.

Described in Chapter I, "Introduction."

C. Objectives.

Described in Chapter I, "Introduction"; and Chapter VI, "Conclusion."

D. Project Characteristics.

Discussed in Chapter II, "Types of Seismic Hazard"; and Chapter III, "Evaluation of Local Seismic Hazard."

SECTION II - DESCRIPTION OF ENVIRONMENTAL SETTING

Regional and local Seismic hazards are discussed in Chapter III, "Evaluation of Local Seismic Hazards." Other aspects of the environmental setting are addressed in the Redding General Plan.

SECTION III - ENVIRONMENTAL IMPACT STATEMENT

A. The Environmental Impact of the Proposed Action.

Since the Element merely formalizes the City's present policy and implementation program regarding Seismic hazards (Chapter VI, "Conclusion") there is no impact associated with the implementation of the Element.

Sources Consulted

Association of Engineering Geologists, Geology and Earthquake Hazards, A Planners Guide to the Seismic Safety Element, July, 1973.

Bay-Valley Consultants, Recommended Water Quality Management Plan, July, 1974.

California Council on Inter-Governmental Relations, General Plan Guidelines, September, 1973.

California Division of Mines and Geology, Urban Geology Master Plan for California, Bulletin 198, 1973.

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California Division of Mines and Geology, State of California Preliminary Fault and Geologic Map, North Half, Preliminary Report 13, Scale 1:750,000, 1973.

California Office of Planning and Research, Environmental Goals and Policy, March 1, 1972.

Comprehensive Planning Organization of the San Diego Region, Model Seismic Safety Element, Final Report, February, 1974.

Governor's Earthquake Council, First Report of the Governor's Earthquake Council, November 21, 1972.

Guyton, J. W. and Scheel, A. L., Earthquake Hazard in Northeast California, California State University, Chico, July 15, 1974.

Joint Committee on Seismic Safety, Meeting the Earthquake Challenge, California State Legislature, January, 1974.

Nichols, Donald R., Guidelines for the Preperation of a Seismic Safety Element, August, 1972.

Planning Commission Subcommittee on Land Use and Development Regulations, Hayward Earthquake Study, Hayward, California, April, 1972.

San Jaoquin County Council of Governments, Seismic Safety Element, May, 1973.